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Assessing human impact on Rostherne Mere, UK, using the geochemistry of organic matter

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Recent changes in the geochemistry of organic material from a hyper-eutrophic lake, Rostherne Mere (UK), were investigated using the stable isotope, geochemical, and molecular composition of radiometrically-dated sediment cores. Modern samples suggest that recent sedimentation is dominated by algal production, however the presence of higher thermal stability components suggests that the sediments also incorporate allochthonous organic material. Sediment cores reveal that absolute proxy values and the magnitude of observed changes are broadly homogenous across the lake basin in both deeper and shallower water environments. A transition to environmental conditions favouring enhanced algal productivity in more recent sediments is suggested by a progression to higher TOC and lower C/N, δ13Corg, and average n-alkane chain length through the cores. A strong covariance between TOC and Rock-Eval Hydrogen Index implies this transition is driven by an increasing algal contribution rather than being a response to variations in the source of organic matter. Decadal trends and abrupt shifts in organic geochemical proxies, such as TOC, δ13Corg, and C/N, are suggested to be directly related to changes in external anthropogenic nutrient loading following the construction and decommissioning of point-source sewage treatment plants, set against a background of intensive agriculture. The development of hyper-eutrophic conditions likely occurred in stages, where rapid transitions are associated with the commencement of sewage effluent input in the 1930s, population increases in the 1980s, and a dramatic reduction in external nutrient loads in the 1990s. Recovery of the lake ecosystem is limited by internal nutrient recycling, and organic proxies indicate that the geochemistry of sediments has remained relatively constant since effluent diversion.